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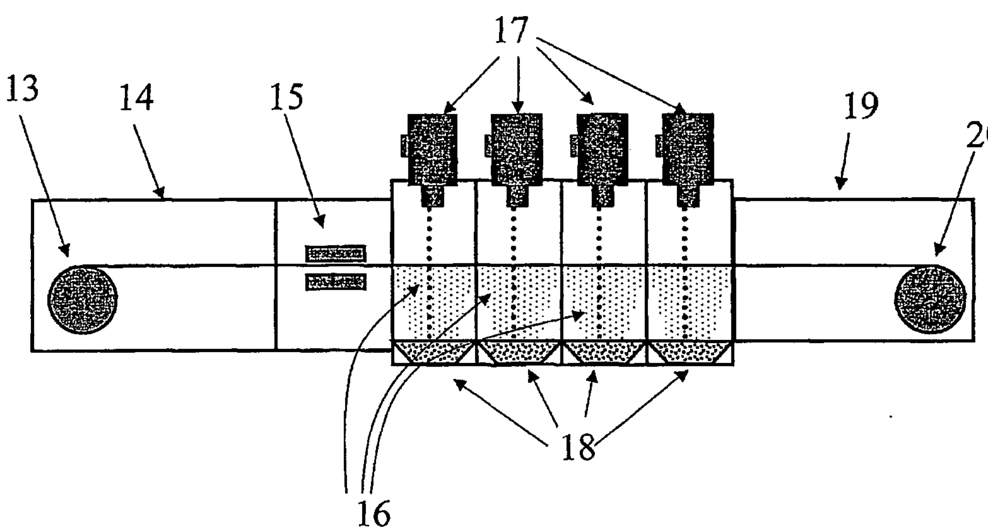
(54) Title: NEW METAL STRIP PRODUCT



(57) Abstract: The present invention relates to a coated steel strip product with a dense and hard abrasion resistant coating on one side or both sides of said strip. The thickness of said coating is in total maximally 25 μm, the hardness of said coating is at least 600 HV and the tensile strength of the steel strip substrate is at least 1200 MPa. The coating is preferably applied by electron beam evaporation and the coating may be, e.g., of Al_2O_3. The coated metal strip is useful for the manufacturing of doctor and coater blades for paper and printing industry.

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NEW METAL STRIP PRODUCT

The present invention relates to a new coated steel strip material with a very hard and dense coating. It also relates to a method of manufacturing such a coated steel strip in a continuous roll-to-roll process which results in a very good adhesion of a hard and dense coating on a metal strip substrate. In particular, it relates to coated steel strips, which have such a good adhesion of the hard coating that they are suitable for use in coater and doctor blade applications.

Background to the invention and prior Art

Doctor and coater blades are used in the manufacturing of paper and in the printing industry, in order to scrape paper and printing ink, respectively, from a rotating roll. In connection to this, problems often arise with wear on the roll and on the coater or doctor blade. Coater and doctor blades are normally manufactured from hardened steel strips. One common way of reducing the wear problem is to apply an abrasion resistant coating to the steel blade after it has been manufactured to its final geometry in the form of a coater or doctor blade. In connection to this, usually a nickel layer must be applied to act as a bond-coat between the substrate and the abrasion resistant coating.

Thus, it is known that abrasion resistant coatings can be used, but there are difficulties to find a cost-efficient and environmentally friendly method that can meet the required quality. The cost for a coater or doctor blade with an applied abrasion resistant coating is at present very high. Moreover, the cost for a quality problem occurring during usage in a printing industry or in a paper mill is high. For cost reasons, a continuous roll-to-roll

coating process, preferably integrated in the production of the steel strip, is therefore required. Further, for quality reasons, a dense coating with very good adhesion to the substrate is of advantage. From a cost perspective, it is also a further advantage if there is such a good adhesion of the abrasion resistant coating that there is no need of any separate bond-coat.

The good adhesion of a dense coating is needed for the functional quality of the finished coater or doctor blade. A poor adhesion, or a porous or coarse coating, would cause problems during usage of the coater blade or doctor blade, e.g., that the coating starts to flake off, or that grains or small pieces are torn off, or that fissure problems occur. All in all, this is not acceptable from a quality and cost perspective, since this type of problem with a doctor blade would result in bad printing quality, or that many frequent stops would be needed in the paper mill, to replace bad coater blades. In a process industry such as a paper mill, each stop is very costly and must be avoided.

There are several common methods of making a coating and also several different types of coatings that are being used. As examples can be mentioned:

- Ceramic coatings, often consisting of Al_2O_3 with possible additions of TiO_2 and/or ZrO_2. This type of coating is normally applied by using a thermal spray method and an example of this method is described in, e.g., US-A-6 431 066, in which a ceramic coating is applied along one edge of a doctor blade. Another example of a method is described in EP-B-758 026, in which a wear resistant coating is applied along one edge using several coating steps in a rather complicated continuous process including thermal spray. Thermal spray methods have normally some major drawbacks. The formed coating is rough which means that polishing or other further

processing must usually be done to the surface after the coating. A thermal spray coating also usually includes a high degree of porosity, implying that a thin dense coating normally can not be achieved. Furthermore, the thickness of thermal sprayed coatings is normally rather high. In the case of coater and doctor blades, the thickness of a ceramic coating is often in the range of 20-100 μm. During usage, a thick and coarse coating has an increased risk of fissure formation or that grains tear off from the surface. In many cases expensive nickel or nickel alloys must also be used as a bond-coat in order to improve the adhesion of the ceramic coating.

- Metallic coatings, often consisting of pure nickel or chromium, or in the form of a compound such as nickel-phosphorus. These types of metallic coatings are normally applied by using a plating method, and especially electrolytic plating. Electrolytic plating methods have some drawbacks, one major being the difficulty to obtain an even thickness and also that the adhesion of the layer can be poor. Also, plating processes are not environmentally friendly, on the contrary, these processes are often causing environmental problems.

- Combinations of coatings, such as a nickel coating comprising abrasion resistant particles, e.g., SiC. One example of this method is described in WO 02/46526, in which different layers are applied in a continuous process for electrolytic nickel coatings in several steps and by adding abrasive particles to at least one of these steps. This method also has some drawbacks, in principle the same drawbacks as for electrolytic plating as described above, but also that nickel is used to a large extent as a bond-coat, meaning that the coating is very expensive.

Thus, the methods as described in the examples above can not be used for the present invention.

Therefore, it is a primary object of the present invention to provide a hard and abrasion resistant coated metal strip with improved adhesion between a dense coating and the substrate.

A further object of the present invention is to obtain a cost-efficient coating in a continuous roll-to-roll process integrated in the production of a steel strip.

Yet another object of the present invention is to provide a coated steel strip product with a dense layer of an abrasion resistant coating, so as to enable the manufacturing of coater and doctor blades of said material.

Still another object of the present invention is to provide a method to manufacture a doctor or coater blade directly in connection to a continuous coating in a roll-to-roll process included in a strip production line, without any need of further manufacturing steps in a separate blade manufacturing.

A further object of the present invention is to obtain a coating with a thickness as uniform as possible.

These and other objects have been surprisingly attained by providing a coated steel product according to claim 1. Further preferred embodiments are defined in the dependent claims.

Brief Description of the Drawings

Figure 1 shows a schematic cross-section of a metal strip according to one embodiment of the invention.

Figure 2 shows a schematic cross-section of a metal strip according to a second embodiment of the invention.

Figure 3 shows schematically a production line for the manufacturing of a coated metal strip material according to the invention.

Detailed description of the invention

The final product, in the form of a hardenable strip steel with a coating of a dense and hard abrasion resistant coating, is suitable in doctor and coater blade applications, such as doctor blades for rotogravure or flexogravure printing, or coater blades for scraping paper in the manufacturing of paper, or creping blades for use in creping of paper in the manufacturing of paper. These are all applications in which wear often arise on the blades, wear originating from the contact with the rolls or wear coming from the paper, which contains abrasive minerals. A suitable coating has a dense layer of an abrasion resistant coating with good adhesion, which is hard but also tough enough to withstand the work-load and pressure during usage, without showing any tendency to brittleness or tearing off.

To prevent the end product from wear, it is suitable to have the product coated with at least one layer of abrasion resistant coating. Both one-sided and two-sided coatings can be used. One-sided coatings is preferable from a cost perspective and should be used whenever possible, and especially in the doctor blade application for use in flexogravure printing, the one-sided coating will normally stand the lifetime needed. For blade applications used in more severe conditions, or during longer running times, two-sided coatings may be preferable. Otherwise, problems may occur with, e.g., plastic deformation along the edge on the uncoated side, or that there is a material build-up along the edge of the uncoated side, which occasionally may

be ripped off from a spot, causing material to locally be torn away from the edge of the coater blade.

The method described in the present invention is suitable for thin coatings of hard and dense abrasion resistant layers in thicknesses on each side up to 25 µm in total, normally up to 20 µm in total, preferably up to 15 µm in total, or at the best maximum 12 µm or even maximum 10 µm in total, is preferable from a cost perspective. If thicker coatings are to be coated, an optimum in cost versus properties may be achieved by using multi-layers with up to 10 layers, and where each layer is between 0,1 to 15 µm thick, suitably between 0,1 to 10 µm, or more suitably 0,1 to 7 µm, preferably 0,1 to 5 µm and even more preferably 0,1 to 3 µm.

The coating is performed at a rate of minimum 2,5 meters per minute, preferably min 5 m/min, most preferably min 10 m/min.

The coating should be sufficiently wear-resistant in order to withstand the wear and shear exerted by the treated material, on the other hand it should not be too thick, due to economical reasons and fragility/brittleness. For coater blade and doctor blade applications, the ratio between the thickness of the coating and the substrate material should be between 0,1% to 12%, normally 0,1 to 10% and usually 0,1 to 7,5% but most preferably between 0,1-5%.

The abrasion resistance can be achieved by depositing at least one layer of dense oxide coating in the form of Al_2O_3, TiO_2 or ZrO_2, or mixtures of these oxides, preferably Al_2O_3 -based. Depending on the requirements, an optimum of required hardness and toughness can be achieved by using mixed oxides in the coating. This can be achieved by co-evaporation of aluminum oxide and another selected oxide. Preferably it can be a co-evaporation of aluminum oxide and any other oxide, preferably TiO_2 and/or ZrO_2. Multi-layers

may also be used in order to enable a combination of oxides so as to optimize hardness and toughness by having up to 10 layers with different oxides in the layers.

In variation to the above-described abrasion resistant coating consisting of essentially oxides, also other dense and hard coatings such as metallic coatings can be used in the present invention. Hard metallic coatings such as essentially pure Cr may be used if a simple and cheap coating is to be preferred in order to reduce cost as much as possible.

Yet another variation of the present invention is to use layers/coatings of transition metal carbides and/or nitrides, such as e.g. TiN, TiC or CrN, also in some cases in combination with an oxide in the form of Al_2O_3, TiO_2 or ZrO_2, or mixtures of these oxides, preferably Al_2O_3 -based. By using the multi-layer system with up to 10 layers, a coating existing of a combination of several layers of different oxides and nitrides can even further enhance the optimum of desired hardness and toughness.

In order to withstand the wear and shear forces on a coater or a doctor blade, the hardness of the thin coating should be above 600 HV, more suitably above 700 HV, preferably above 800 HV and most preferably above 900 HV.

The tolerances of each layer is maximum + /- 10% of the layer thickness at strip widths up to 400 mm. This means that very tight tolerances can be achieved, which is of benefit for the precision during usage and the quality of the product. In comparison to plating or thermal spray this represents much higher tolerances. For instance, in plating there is a so called dog-bone effect, which results in varying thicknesses of the layer. In that case, the layer usually varies more than +/- 50% of the layer thickness.

There is no need of any separate bond-coat, but nickel may still be used in one of the layers if it is required

from a technical perspective, e.g., to enhance toughness. Since nickel is expensive it is usually used in very thin layers only, suitably between 0 to 2 µm, preferably between 0-1 µm and most preferably between 0-0,5 µm. However, any possible nickel layer would not be the layer adjacent to the substrate.

Description of the substrate material to be coated

The material to be coated should have a good basic mechanical strength, suitable for a coater or doctor blade application. Preferably, it should be a hardenable steel in a hardened and tempered condition, or alternatively a precipitation hardenable steel, such as the alloy disclosed in WO 93/07303, which in the end condition can achieve a tensile strength level above 1200 MPa, or preferably more than 1300 MPa, or at the best above 1400 MPa, or even 1500 MPa. If the coater or doctor blade is intended for use in a corrosive environment, then the steel alloy should also have a sufficient addition of chromium to enable a good basic corrosion resistance. The Cr content should in this case be above 10% by weight, or at least 11%, or preferably a minimum of 12%.

The coating method may be applied on any kind of product made of said type of steel alloy and in the form of a strip that has good hot workability and also can be cold-rolled to thin dimensions. The alloy should also be capable of readily being manufactured to coater or doctor blade applications in a manufacturing process including steps such as forming, grinding, shaving, cutting, polishing, stamping, or the like. The thickness of the strip substrate material is usually between 0,015 mm to 5,0 mm and suitably between 0,03 mm to 3 mm. Preferably, it is between 0,03 to 2 mm, and even more preferably between 0,03 to 1,5 mm. The width of the substrate material depends on if the coating

is made before or after the slitting operation. Further, said width should preferably be selected to be a width suitable for further manufacturing to the final width of the coater or doctor blade. In principle, the width of the substrate material is therefore between 1 to 1500 mm, suitably 1 to 1000 mm, or preferably 1 to 500 mm, or even more preferably between 5 and 500 mm. The length of the substrate material is suitably between 10 and 20 000 m, preferably between 100 and 20 000 m.

Description of the Coating Method

A variety of physical or chemical vaporation deposition methods for the application of the coating media and the coating process may be used as long as they provide a continuous uniform and adherent layer. As exemplary of deposition methods can be mentioned chemical vapor deposition (CVD), metal organic chemical vapor deposition (MOCVD), physical vapor deposition (PVD) such as sputtering and evaporation by resistive heating, by electron beam, by induction, by arc resistance or by laser deposition methods, but for the present invention especially electron beam evaporation (EB) is preferred for the deposition. Optionally, the EB evaporation can be plasma activated to even further ensure good quality coatings of hard and dense layers.

For the present invention, it is a pre-requisite that the coating method is integrated in a roll-to-roll strip production line. The hard coating is then deposited by means of electron beam evaporation (EB) in a roll-to-roll process. If multi layers are needed, the formation of them can be achieved by integrating several EB deposition chambers in-line. The deposition of metallic coatings should be made under reduced atmosphere at a maximum pressure of 1 x 10^{-2} mbar with no addition of any reactive gas to ensure essentially pure metal films. The deposition

of metal oxides should be performed under reduced pressure with an addition of an oxygen source as reactive gas in the chamber. A partial pressure of oxygen should be in the range 1 - 100 x 10^{-4} mbar. If other types of coatings are to be achieved, e.g., transition metal carbides and/or nitrides such as TiN, TiC or CrN, or mixtures thereof with, e.g., metal oxides, the conditions during the coating should be adjusted with regard to the partial pressure of a reactive gas so as to enable the formation of the intended compound. In the case of oxygen a reactive gas such as H_2O, O_2 or O_3, but preferably O_2, may be used. In the case of nitrogen a reactive gas such as N_2, NH_3 or N_2H_4, but preferably N_2, may be used. In the case of carbon, any carbon containing gas may be used as reactive gas, for an example CH_4, C_2H_2 or C_2H_4. All these reactive EB evaporation processes may be plasma activated.

To enable a good adhesion, different types of cleaning steps are used. First of all, the surface of the substrate material should be cleaned in a proper way to remove all oil residues, which otherwise may negatively affect the efficiency of the coating process and the adhesion and quality of the coating. Moreover, the very thin native oxide layer that normally always is present on a steel surface must be removed. This can preferably be done by including a pre-treatment of the surface before the deposition of the coating. In this roll-to-roll production line, the first production step is therefore preferably an ion assisted etching of the metallic strip surface to achieve good adhesion of the first coating [see Fig. 3].

Description of embodiments of the invention

Two examples of embodiments of the invention will now be described in more details. The first example (Figure 1) comprises a coating 1,2 for a substrate material 3 in full

strip width. The substrate material can be made of different alloys, such as a hardenable carbon steel or a hardenable stainless chromium steel. The other example (Figure 2) comprises a coating 4 of a steel strip 5, which before the coating process, has been both slitted and edge treated to a width in principle twice the final width of the coater blade. During coating, both the main sides 7,8 and the narrow lateral sides 9,10 are coated, thereby obtaining a complete coating around the scraping or cutting edges 11,12. Suitably, the lateral sides 9 and 10 are coated simulateneously with the somewhat narrower main side 7. The examples given are only intended as illustrative examples to the invention and may not serve as a limitation to the present innovation.

The substrate material should have a composition suitable for hardening, which means:

- Hardenable carbon steel of 0,1-1,5% C, 0,001-4% Cr, 0,01-1,5% Mn, 0,01-1,5% Si, up to 1% Ni, 0,001-0,5%N, rest essentially Fe; *or*
- Hardenable chromium steels of 0,1-1,5% C, 10-16% Cr, 0,001-1% Ni, 0,01-1,5% Mn, 0,01-1,5% Si, up to 3% Mo, 0,001-0,5% N, rest essentially Fe; *or*
- Precipitation hardenable steels of: 0,001-0,3% C, 10-16% Cr, 4-12% Ni, 0,1-1,5% Ti, 0,01-1,0% Al, 0,01-6% Mo, 0,001-4% Cu, 0,001-0,3% N, 0,01-1,5% Mn, 0,01-1,5% Si, rest essentially Fe.

<u>Example 1</u>

The chemical compositions of the substrate materials in the example are according to the internal Sandvik designation 20C2 and 13C26, with essentially the following nominal composition:

Sandvik 20C2: 1,0% C, 1,4% Cr, 0,3% Si and 0,3% Mn (by weight); and

Sandvik 13C26: 0,7% C, 13% Cr, 0,4% Si and 0,7% Mn (by weight).

Firstly, the substrate materials are produced by ordinary metallurgical steelmaking to a chemical composition as described above. After this, they are hot-rolled down to an intermediate size, and thereafter cold-rolled in several steps with a number of recrystallization steps between said rolling steps, until a final thickness of 0,2 mm and a width of maximally 400 mm. Thereafter the strip steels are hardened and tempered to the required mechanical strength level, which according to the present invention should be at least 1200 MPa. The surface of the substrate material is then cleaned in a proper way to remove oil residuals from the rolling and hardening operations. Thereafter, the coating process takes place in a continuous process line, starting with decoiling equipment. The first step in the roll-to-roll process line can be a vacuum chamber or an entrance vacuum lock followed by an etch chamber, in which ion assisted etching takes place in order to remove the thin oxide layer on the substrate material. The strip then enters into the EB evaporation chamber(s) in which deposition of an oxide takes place, in this example Al_2O_3 is selected as the material to be deposited. An oxide layer of normally 0,1 up to 25 µm is deposited; the preferred thickness depends on the application. In the examples described here, a thickness of 2 µm is deposited by using one EB evaporation chamber. After the EB evaporation, the coated strip material passes through the exit vacuum chamber or exit vacuum lock before it is being coiled on to a coiler. The coated strip material can now, if needed, be further processed by for an example slitting and edge treatment, to obtain the preferred final dimension and edge condition for the manufacturing of a coater blade. It is an advantage if

an additional coating along the edge of the finished coater blade application can be made in a continuous coating process using EB evaporation, but also other processes may be used. Preferably, an additional coating along the edge of a finished blade is of same type as the coating applied on the strip material according to the present invention.

The end product as described in this examples, i.e. a coated 20C2 and 13C26-strip material respectively, in a strip thickness of 0,2 mm and with a thin coating of Al_2O_3 of 2 µm, has a very good adhesion of the coated layer and is thus suitable to use especially for the manufacturing of doctor blades for flexogravure or rotogravure printing.

The roll-to-roll electron beam evaporation process referred to above is illustrated in Figure 3. The first part of such a production line is the uncoiler 13 within a vacuum chamber 14, then the in-line ion assisted etching chamber 15, followed by a series of EB evaporation chambers 16, the number of EB evaporation chambers needed can vary from 1 up to 10 chambers, this to achieve a multi-layered structure, if so desired. All the EB evaporation chambers 16 are equipped with EB guns 17 and water-cooled copper crucibles 18 for the evaporation. After these chambers comes the exit vacuum chamber 19 and the recoiler 20 for the coated strip material, the recoiler being located within vacuum chamber 19. The vacuum chambers 14 and 19 may also be replaced by an entrance vacuum lock system and an exit vacuum lock system, respectively. In the latter case, the uncoiler 13 and the coiler 20 are placed in the open air.

Example 2

The chemical composition of the substrate material in this example is according to the internal Sandvik designation 20C with essentially the following nominal composition: Sandvik 20C: 1,0% C, 0,2% Cr, 0,3% Si and 0,4% Mn (by weight).

Firstly, the substrate material is produced by ordinary metallurgical steelmaking to a chemical composition as described above. The material is then hot-rolled down to an intermediate size, and thereafter cold-rolled in several steps with a number of recrystallization steps between said rolling steps, until a final thickness of 0,45 mm and a width of maximum 400 mm are attained. Thereafter, the steel strip is hardened and tempered to the required mechanical strength level, according to the present invention above 1200 MPa. The strip is afterwards slitted to a width corresponding to substantially twice the width of the final blade application. According to this example, the final coater blade width is 100 mm and the strip is thus slitted to a width of between 200-250 mm. The edges along the slitted strip are then edge-treated, for example shaved, ground and polished, to the conditions and geometry considered suitable for the intended coater blade application. After this, the strip is submitted to a coating treatment fully analogous to Example 1, cf. also Figure 3. The end product will be a coated strip according to Figure 2, the coating material and thickness being the same as in Example 1. Now, the coated strip material can be slitted in the middle along section 6 to obtain two coated strips, each with the dimension and edge geometry suitable for a finished coater blade. In principle, only cutting into required final length remains.

The end product as described in this example, i.e. a slitted, edge treated and coated strip material, in a strip thickness of 0,45 mm and a final slitted width of 100 mm,

has a thin covering aluminum oxide coating of 2 µm with a very good adhesion of the coated layer. This product can be cut into required length, normally in between 3-10 m, and then used as a coater blade in a paper mill, without any further processing. It may also, if required, be further processed, e.g., with an additional edge treatment or with additional coatings along the edge, or polishing or the like, in order to meet a specific customer demand. An additional coating along the edge of the finished coater blade application, can preferably be made in a continuous coating process using EB evaporation, but also other processes may be used.

CLAIMS

1. A coated steel strip product with a dense and hard abrasion resistant coating on one side or both sides of said strip *characterized in that*, said coating is applied directly on to the steel strip substrate, the thickness of said coating is in total maximally 25 μm, the hardness of said coating is at least 600 HV and the tensile strength of the steel strip substrate is at least 1200 MPa.

2. Product according to claim 1 *characterized in that* the thickness of the strip substrate is between 0,015 mm and 5,0 mm.

3. Product according to claim 1 or 2, *characterized in that* in that the strip substrate is made of hardenable carbon steel, or hardenable stainless chromium steel, or precipitation hardenable strip steel.

4. Product according to any of claims 1-3, *characterized in that* the coating is substantially made of Al_2O_3.

5. Product according to any of claims 1-3, *characterized in that* the coating is a mixture of Al_2O_3 and TiO_2 and/or ZrO_2, the main ingredient being Al_2O_3.

6. Product according to any of claims 1-3, *characterized in that* the coating is a metallic coating containing essentially Cr.

7. Product according to any of claims 1-3, *characterized in that* the coating is a coating of transition metal carbides or transition metal nitrides, preferably TiN, TiC or CrN, or mixtures thereof.

8. Product according to any of the preceding claims, *characterized in that* the coating has a multi-layer constitution of up to 10 layers.

9. Product according to claim 8, *characterized in that* the each individual layer has a thickness of between 0,1 to 15 μm.

10. Product according to claim 9, *characterized in that* the coating has a multi-layer constitution of individual layers of different coatings of oxides in the form of Al_2O_3, TiO_2 or ZrO_2, or mixtures thereof, and if desired also in combination with layers of nitrides or carbides such as TiN and TiC, and also if further desired, a metallic coating such as Cr.

11. Product according to claim 10, *characterized in that* there is also at least one layer of nickel in thickness up to 2 μm, this nickel layer not being adjacent the strip substrate.

12. Method of manufacturing a coated steel strip product according to any of the preceding claims, *characterized in that* said product is produced at a rate of at least 2.5 m/min, in a continuous roll-to-roll process included in a strip production line

using electron beam evaporation including an etch chamber in-line.

13. A doctor or coater blade which is suitable for, e.g., the paper and printing industry, comprising a coated steel strip product according to any of claims 1-11.

14. A doctor or coater blade according to claim 13, *characterized in that* its lateral scraping and/or cutting side is also coated with the same coating composition as the main sides.

15. Method of manufacturing a doctor or coater blade according to any of claims 13 to 15, *characterized in that* said blade is produced at a rate of at least 2.5 m/min in a continuous roll-to-roll coating process included in a metal strip production line using electron beam evaporation including an etch chamber in-line, said blade being manufactured by using a strip width substantially corresponding to twice the width of the final doctor or coater blade.

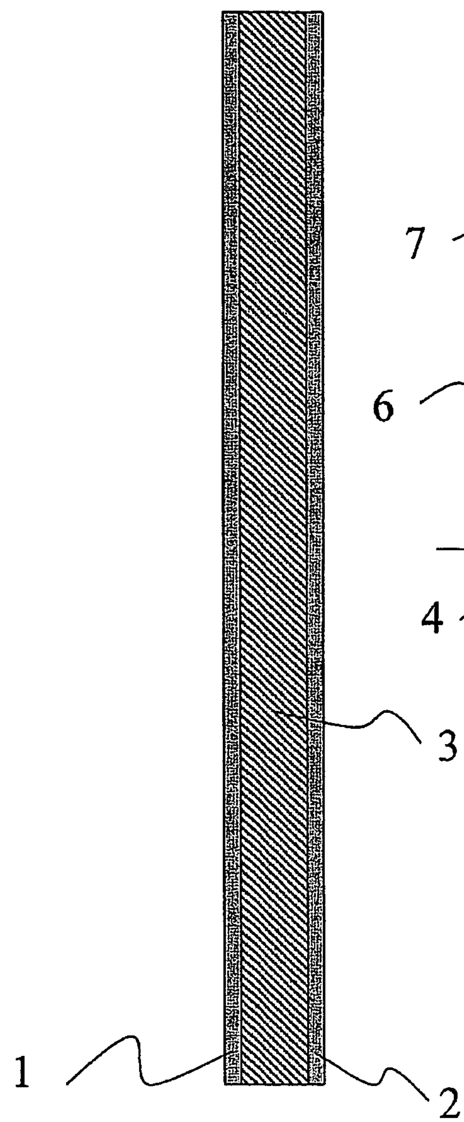

Fig. 1

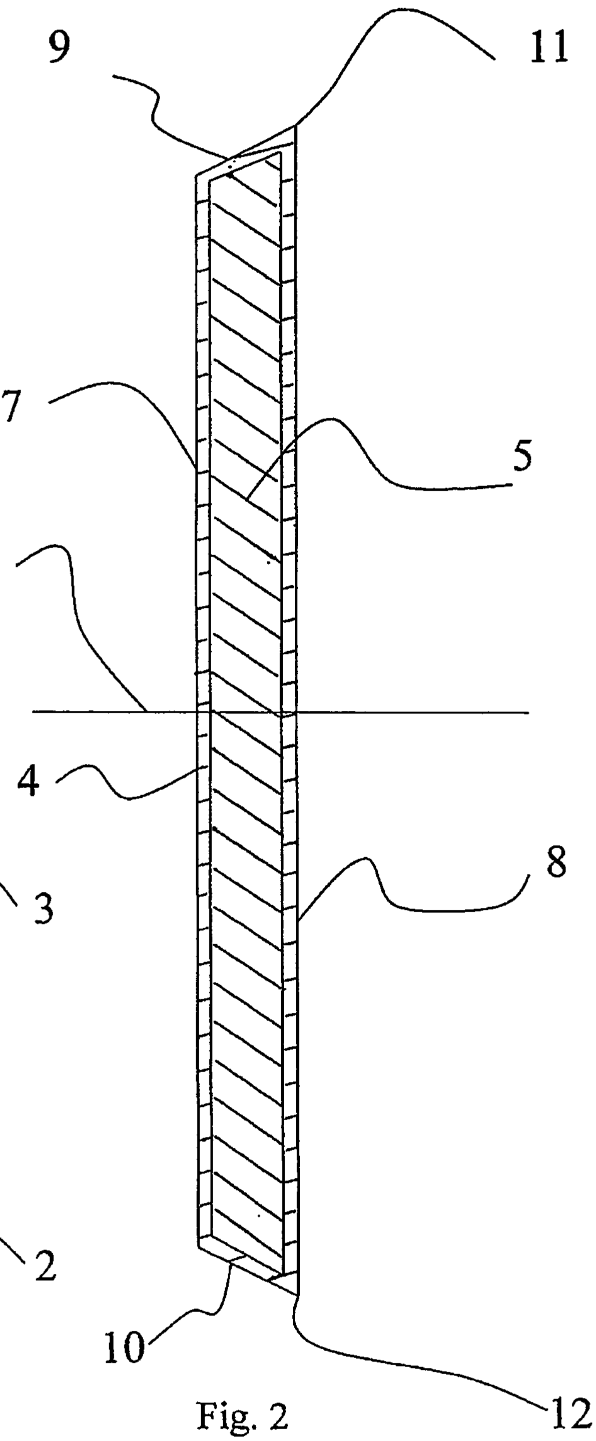

Fig. 2

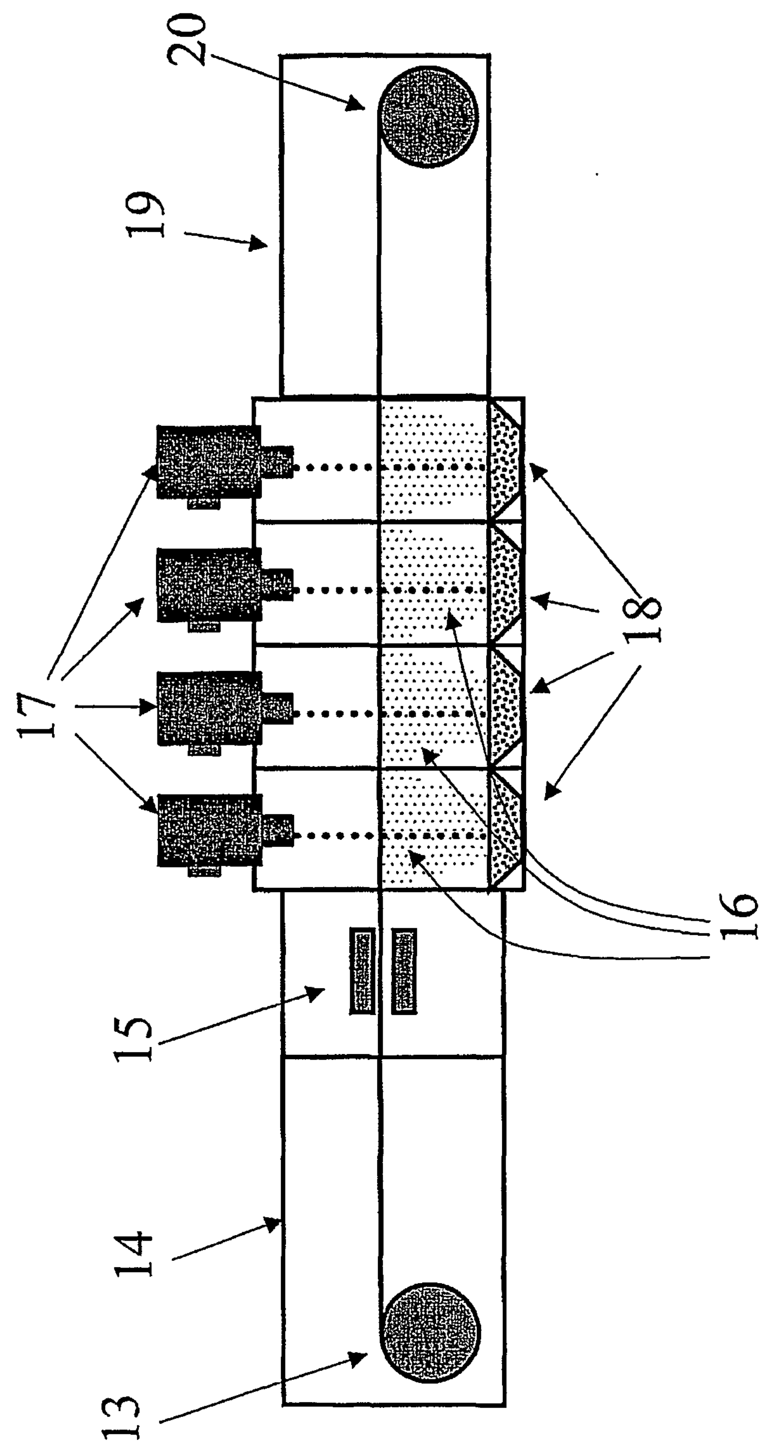

Fig. 3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 2004/001171

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: C23C 14/06, C23C 14/56

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: C23C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 0100402 A1 (LJUNGCRANTZ, HENRIK), 4 January 2001 (04.01.2001), page 2, line 21 - page 3, line 10, figure 1, abstract	1-12
Y		13
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Y	DATABASE WPI Week 198810 Derwent Publications Ltd., London, GB; Class L02, AN 1988-067157 & JP 63 020447 A (NISSHIN STEEL CO LTD), 28 January 1988 (1988-01-28) abstract, figure 1	13
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[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
29 November 2004	01 -12- 2004
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Lars Hennix/EÖ Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 2004/001171

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 9954520 A1 (VALMET CORPORATION), 28 October 1999 (28.10.1999), page 4, line 2 - line 29; page 7, line 29 - page 8, line 1, abstract --	14-16
A	US 5958134 A (TURGRUL YASAR ET AL), 28 Sept 1999 (28.09.1999), abstract --	14-16
A	US 5227203 A (HIROCHI KIBE ET AL), 13 July 1993 (13.07.1993), column 2, line 29 - line 45, abstract --	1-15
A	US 4763601 A (SEICHIRO SAIDA ET AL), 16 August 1988 (16.08.1988), abstract --	1-15
A	WO 0246526 A1 (SWEDEV AKTIEBOLAG), 13 June 2002 (13.06.2002), abstract --	1-15
A	EP 0758026 A1 (PACIFIC SAW AND KNIFE COMPANY), 12 February 1997 (12.02.1997), abstract -- --------	1-15

INTERNATIONAL SEARCH REPORT	International application No. PCT/SE2004/001171

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see next sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☒ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest
☐ The additional search fees were accompanied by the applicant's protest.
☐ No protest accompanied the payment of additional search fees.

The invention according to claim 1 relates to a coated steel strip product with a dense and hard abrasion resistant coating. Such a steel product is known through WO0100402 A1. Consequently, the application has been found to á posteriori constitute two groups of inventions:

I. Claims 2-11 relating to coated steel strip product, claim 13 relating to method for manufacturing a coated steel strip product.
II. Claims 13, 14 relating to a doctor or coater blade comprising a coated steel strip product according to any of claims 1-12. Claim 15 relating to a method of manufacturing a doctor blade.

No same or corresponding technical features above the general state of the art can be identified between the two groups of inventions.

The two groups of inventions has however been covered by the news search.

INTERNATIONAL SEARCH REPORT

Information on patent family members

30/10/2004

International application No.
PCT/SE 2004/001171

WO	0100402	A1	04/01/2001	AU	3093300	A	12/07/2000
				AU	5863200	A	31/01/2001
				EP	1142373	A	10/10/2001
				JP	2002534021	T	08/10/2002
				SE	513219	C	31/07/2000
				SE	9902411	A	31/07/2000
WO	9954520	A1	28/10/1999	AU	3424199	A	08/11/1999
				FI	980884	A	23/10/1999
US	5958134	A	28/09/1999	AU	6046496	A	30/12/1996
				EP	0800438	A	15/10/1997
				TW	385337	B	00/00/0000
				WO	9640472	A	19/12/1996
US	5227203	A	13/07/1993	DE	4217450	A,C,R	26/08/1993
				JP	5230654	A	07/09/1993
				JP	6021804	U	22/03/1994
				KR	9500010	B	07/01/1995
				JP	2596202	Y	07/06/1999
				JP	5239630	A	17/09/1993
				JP	6005410	U	25/01/1994
US	4763601	A	16/08/1988	DE	3786800	D,T	10/02/1994
				EP	0305573	A,B	08/03/1989
WO	0246526	A1	13/06/2002	AU	1860602	A	18/06/2002
				EP	1349986	A	08/10/2003
				JP	2004515651	T	27/05/2004
				SE	519466	C	04/03/2003
				SE	0004506	A	08/06/2002
				US	20040137261	A	15/07/2004
EP	0758026	A1	12/02/1997	SE	0758026	T3	
				AT	208438	T	15/11/2001
				CA	2167037	A	09/02/1997
				DE	69616690	D,T	01/08/2002
				JP	9122581	A	13/05/1997
				NO	314904	B	10/06/2003
				NO	963262	A	10/02/1997
				US	5728434	A	17/03/1998